

TIMING MULTIPLE EVENTS WITH A SINGLE TIMER

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BACKGROUND INFORMATION

The invention relates generally to devices and methods to time events. In existing computer-based systems, a timer is required for each type of event to be timed. Using many timers can tie up valuable computing time.

BRIEF DESCRIPTION OF THE DRAWINGS

Reference should be made to the following detailed description taken in conjunction with the accompanying drawings, in which:

Figures 1A through 1C are a block flow diagram of one method in accordance with an embodiment of the invention;

Figures 2A and 2B are a block flow diagram of a second method in accordance with an embodiment of the invention;

Figures 3A and 3B are a block flow diagram of a third method in accordance with an embodiment of the invention;

Figure 4 is a time line illustrating aspects of a method in accordance with an embodiment of the invention; and

Figure 5 illustrates an article of manufacture in accordance with an embodiment of the invention.

DETAILED DESCRIPTION

5 Before providing certain details, an overview of a method according to an embodiment of the invention may be helpful. In a method according to an embodiment of the invention, a set of durations may be received. The set of durations includes at least two time durations, and each duration corresponds to a respective action signal to be sent at the end of the respective duration. An expiration time corresponding to each duration may be determined, and the expiration time that is first to occur may be selected. When the selected expiration time occurs, the action signal corresponding to the selected expiration time may be sent. The foregoing procedure may be repeated with the next expiration time(s) until there are no more expiration times to be selected. As a result, a method according to an embodiment of the invention allows for the use of a single timer to time multiple events.

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 Figures 1A through 1C depict a method of determining when to send a signal according to an embodiment of the invention. A clock, capable of indicating a current time, may be provided 100. The

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clock may be the system clock of a computer. A first
time duration corresponding to a first action signal may
be received 103. The time duration may be the amount of
time that should be allowed to lapse before an action is
5 taken. For example, many software programs require
certain routines to pause for a specified duration to
allow other routines to be executed. In that situation,
the time period corresponding to the pause may be the
first time duration. At the end of the first time
10 duration, the paused routines may be started, for
example, by the first action signal.

A first received time may be determined 106. The
first received time may correspond to the current time
indicated by the clock when the first time duration was
15 received. Next, a first expiration time may be
determined 109. The first expiration time may be
approximately equal to the first received time plus the
first time duration.

A second time duration corresponding to a second
20 action signal may be received 112. The second time
duration may be similar to the first time duration in
that the second time duration may also be related to a
pause in a routine, and similarly the second action
signal may also be a signal that starts that routine
25 after the pause.

A second received time and second expiration time may be determined 115, 118. The second received time corresponds to the current time indicated by the clock when the second time duration was received. The second
5 expiration time may be approximately equal to the second received time plus the second time duration.

Next, the first expiration time may be compared 121 to the second expiration time, and one or both of the expiration times may be selected 124. The first
10 expiration time may be selected if the first expiration time is less than the second expiration time. The second expiration time may be selected if the second expiration time is less than the first expiration time. Both the first and second expiration times may be
15 selected if the first expiration time is approximately equal to the second expiration time.

A signal send time may be determined. If the first expiration time is not approximately equal to the second expiration time, the signal send time may be set 127
20 approximately equal to the selected one of the first expiration time and the second expiration time. However, if the first expiration time is approximately equal to the second expiration time, the signal send time may be set 127 approximately equal to the first and
25 second expiration time.

A start time corresponding to the current time indicated by the clock may be determined 130, and a time difference between the signal send time and the start time may be determined 133. A timer, capable of sending
5 a call back signal at the end of a time period, may be provided 136, and the time period may be set 139 approximately equal to the time difference. Then the timer may be started 142 at the start time, and once the timer sends 145 the call back signal, the first action
10 signal may be sent 148 if the first expiration time was selected, and the second action signal may be sent if the second expiration time was selected.

In order to make sure there is time to execute portions of the method, for example sending the call
15 back signal and then sending the action signal at the expiration time, the time period may be made less than the time difference. It is therefore anticipated that the time period may not be equal to the time difference, but instead may be equal to the time difference minus
20 some amount of time needed to execute portions of the method, such as those portions that occur from the time a call back signal is sent to the time an action signal is sent.

Once the time period has expired and the timer
25 sends the call back signal, a next expiration time may

be selected. The next expiration time may correspond to the first expiration time if the first expiration time was not previously selected, and the next expiration time may correspond to the second expiration time if the second expiration time was not previously selected.

Then a new start time may be determined, and a new time difference between the next expiration time and the new start time may be determined. Then the time period may be set approximately equal to the new time difference, and the timer may be started at the new start time. This process may be repeated until there are no more expiration times to be selected.

In an embodiment of the invention, indicators corresponding to time durations may be provided. An indicator indicates whether the corresponding time duration should be received again after the corresponding action signal has been sent. As an example of this embodiment, upon sending the first action signal, the first indicator may be checked and if the first indicator indicates the first action signal should be sent again, the first time duration may be received again. Then a third received time may be determined. The third received time corresponds to the current time indicated by the clock when the first time duration was received again, or alternatively, when the

first action signal was sent. Then, a third expiration
time may be determined. The third expiration time may
be approximately equal to the third received time plus
the first time duration. The method may proceed using
5 the third expiration time and information corresponding
to the second expiration time.

FIG. 1

Figures 2A and 2B illustrate another method
according to an embodiment of the invention. In this
method a clock, capable of indicating a current time,
10 may be provided 200, and a set of durations may be
received 203. The set of durations includes at least
two time durations, each duration corresponding to a
respective action signal to be sent at the end of the
respective duration. A received time for each duration
15 may be determined 206, each received time being the
current time indicated by the clock when the duration
was received. An expiration time corresponding to each
duration may be determined 209 to provide a set of
expiration times. Each expiration time may be
20 approximately equal to the corresponding received time
plus the corresponding time duration. Then the
expiration times may be compared 212 to determine which
of the expiration times is first to occur. The
expiration time that is first to occur may be selected
25 215 to provide a selected expiration time.

Then a start time may be determined 218, and a time difference between the selected expiration time and the start time may be determined 221. The start time may be the current time indicated by the clock.

5 A timer that is capable of sending a call back signal at the end of a time period may be provided 224. The time period may be set 227 approximately equal to the time difference, and the timer may be started 230 at the start time. At the end of the time period, the call
10 back signal may be sent 233. Once the call back signal is sent, all action signals corresponding to an expiration time that corresponds to the selected expiration time may be sent 236 at the selected expiration time. As described above, it may be
15 beneficial to make the time period less than the time difference to allow for the time needed to perform portions of the method before sending the action signal.

After the time period expires, the expiration time that is next to occur may be selected from the set of
20 expiration times. A new start time may be determined, and a new time difference between the selected expiration time that is next to occur and the start time may be determined. The time period may be set approximately equal to the new time difference, and the
25 timer may be started at the new start time. At the end

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of the time period, the timer may again send a call back
signal, and the action signals that correspond to an
expiration time corresponding to the selected expiration
time that is next to occur may be sent at the selected
5 expiration time.

The method may further include adding an expiration
time to the set of expiration times. For example, it
may be desirable for a time duration to be effectively
received again after the corresponding action signal has
10 been sent. In that situation, an expiration time may be
added to the set of expiration times that may be
approximately equal to the time the action signal was
sent plus the corresponding duration. One way of
accomplishing this may be to provide an indicator
15 corresponding to the sent action signal. The indicator
may be provided along with the corresponding duration.
Once the action signal is sent, the indicator may be
checked to determine whether the indicator is turned on
or turned off. If the indicator is turned on, the
20 expiration time may be determined and added to the set
of expiration times.

Figures 3A and 3B illustrate another method
according to an embodiment of the invention. In this
method, first timing information may be received 300.
25 The first timing information corresponds to a first

action signal and includes a first duration and a first flag. The flag may be turned on or turned off, for example by a computer software routine. The flag may be used to indicate whether the duration should be used, and ultimately, whether the corresponding action signal should be sent at the end of the duration. If the first flag is turned on, indicating an active status, a first expiration time may be determined 303 and included in a set of expiration times to be considered.

Second timing information also may be received 306 that corresponds to a second action signal. The second timing information includes a second duration and a second flag. If the second flag indicates an active status, then a second expiration time may be determined 309 and included in the set of expiration times. Then a determination 312 may be made as to which of the expiration times in the set will occur first, in order to provide a selected expiration time.

A start time may be determined 315, and a time difference, approximately equal to a difference between the selected expiration time and the start time, may be determined 318. Then a timer, capable of sending a call back signal at the end of a time period, may be provided 321, and the time period may be set 324 approximately equal to the time difference. As noted above, it may be

beneficial to make the time period less than the time difference to allow for the time needed to perform portions of the method before sending the action signal. The timer may be started 327 at the start time, and once
5 the time period has expired, the timer sends 330 the call back signal. Action signals that correspond to an expiration time corresponding to the selected expiration time may be sent 333.

After the call back signals are sent, at least one
10 of the flags corresponding to the selected expiration time may be set to an inactive status. To accomplish this, the timing information may include an indicator, as described above. For example, if a first indicator corresponding to first timing information is provided,
15 then upon sending the first action signal, a determination may be made as to whether the indicator is turned on or turned off. If the first indicator is turned on and the first flag indicates an active status, then a third expiration time may be determined. The
20 third expiration time corresponds to the first action signal, and may be computed by adding the first duration to the current time indicated by the clock when the first action signal was sent. Once the third expiration time is determined, the third expiration time may be
25 included in the set of expiration times to be

considered. Then a determination may be made as to which of the expiration times in the set will next occur in order to provide a new expiration time. A new start time may be determined, and the time period may be set approximately equal to a difference between the new expiration time and the new start time. Then the timer may be started at the new start time, and once the new time period expires, the timer sends the call back signal, and action signals that correspond to an expiration time that corresponds to the new expiration time may be sent.

If it is determined that the indicator is turned off, then once the corresponding action signal is sent, the first flag may be set to an inactive status. In this situation, in order to cause the corresponding timing information to again be considered, and ultimately to again send the corresponding action signal, the flag would need to be set to an active status, for example by a computer software routine.

It will now be recognized that the timer may need to be capable of accounting for time periods that are shorter than the shortest duration. If the timer can account for relatively short time periods, the time period accounted for by the timer can be made shorter than the time difference referenced above so that there

is time to determine the time difference, set the time period, start the timer and send the call back signal before the action signal must be sent.

5 In addition, it will now be recognized that the invention allows for the use of a single timer to time multiple events. An embodiment of the invention may be implemented so that if the timer is currently timing a particular time period corresponding to a particular expiration time and a duration is received, an
10 expiration time corresponding to that newly received duration may be determined. The newly determined expiration time may be compared to the expiration time that corresponds to the time period being accounted for by the timer. If the newly received expiration time is
15 earlier than the expiration time corresponding to the time period being accounted for, then a new time period may be determined that corresponds to the newly received expiration time. The timer may be set with the new time period, and then started.

20 There may be a situation in which there are no more expiration times or corresponding durations for which a corresponding action signal should be sent. In those situations, the timer may be turned off, or placed in a ready-state awaiting for the next duration to be
25 received.

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When an embodiment of the invention is implemented on a computer to time events required by computer software, the application interface to the portion of the software needing timer support may be very simple.

5 Many of the execution steps related to timing an event are done in a manner that requires few pieces of information from, and very little interaction with, the computer software needing timer support.

10 Certain aspects of an embodiment of the invention will now be illustrated by way of an example. Figure 4 shows a time line 400 that starts at time = 0 and extends through time = 40. Every five units of time are marked on the time line 400 for reference purposes. Immediately above the time line is a row of information 15 403 labeled "AS to be sent in", and the information in this row 403 reflects the time remaining before an action signal ("AS") is sent. Immediately above the "AS to be sent in" row 403 is a row 406 titled "expiration time", and the information in this row 406 reflects the 20 expiration time for which the timer is currently accounting.

For purposes of this example, assume timing information A is received at time = 5. The box labeled "A" above time = 5 shows the status of timing 25 information A at time = 5. Timing information A

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includes a duration of 30 time units (signified by the "D" next to the number 30). The corresponding expiration time is therefore at time = 35 (signified by the "E" next to the number 35). Also included in timing information A may be an indicator that has been turned on (signified by the number 1 next to the "I") and a flag that may be in the active state (signified by the number 1 next to the "F").

Assuming timing information A is the only piece of timing information pending at time = 5, the expiration time is determined to be time = 35. A start time and time period are selected so that the action signal will be sent at time = 35, and the timer is started.

At time = 14.9, the timer is still timing the time period corresponding to timing information A. Then, at time = 15, timing information B is received. The box labeled "B" above time = 15 shows the status of timing information B at time = 15. Timing information B has a duration of 10 time units, an indicator in the "off" state, and a flag in the "active" state. An expiration time corresponding to timing information B is determined to be time = 25. The expiration time corresponding to timing information A (time = 35) is compared to the expiration time corresponding to timing information B (time = 25). Since the expiration time corresponding to

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timing information B will occur first, a start time and time period are selected so that the action signal corresponding to timing information B will be sent at time = 25, and the timer is started.

- 5 At time = 19.9, the timer is still accounting for the time period corresponding to timing information B. Then, at time = 20, timing information C is received. Timing information C has a duration of 50 time units, an indicator in the "off" state, and a flag in the "active" state. An expiration time corresponding to timing information C is determined to be time = 70. The expiration time corresponding to timing information B (time = 25) is compared to the expiration time corresponding to timing information C (time = 70).
- 10 Since the expiration time corresponding to timing information B will occur first, the timer is not reset, and is allowed to continue accounting for the existing time period, of which there are 5 time units remaining when timing information C is received.
- 15 Next, the timer sends a call back signal, and the action signal corresponding to timing information B is sent at time = 25. Since the indicator in timing information B is in the "off" state, the flag is set to the "inactive" state. The flag may be changed to the
- 20 "active" state upon a command to do so from the software
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associated with timing information B. The box labeled "B" above time = 25 shows the status of timing information B at time = 25.

After the call back signal is sent, the expiration times corresponding to the remaining pieces of timing information, timing information A and timing information C, are compared. Since the expiration time corresponding to timing information A (time = 35) will occur before the expiration time corresponding to timing information C (time = 70), a start time and time period are selected so that the action signal corresponding to timing information A will be sent at time = 35, and the timer is started.

At time = 34.9, the timer is accounting for the time period corresponding to timing information A. When the time period expires, the timer sends the call back signal, and at time = 35 the action signal corresponding to timing information A is sent. Since timing information A has an indicator that is turned on, the 30 time unit duration of timing information A is again used. The expiration time corresponding to timing information A is then determined to be time = 65. The box labeled "A" above time = 35 shows the status of timing information A at time = 35. The expiration time corresponding to timing information A (time = 65) is

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compared to the expiration time corresponding to timing
information C (time = 70), and the expiration time
corresponding to timing information A is determined to
be the first to occur. A start time and time period are
5 selected so that the action signal corresponding to
timing information A will be sent at time = 65, and the
timer is started.

Figure 5 shows an embodiment of a system according
to the invention wherein a computer 500 has computer
10 software running thereon. The computer 500 may be
connected via a connection line 503 to a transmission
line 506 carrying requests for a timer and a return
action signal. The computer software may be stored on
an article of manufacture 509, such as a computer
15 readable storage medium, for example a compact-disc, and
loaded onto the computer 500, for example via a compact-
disc drive 512.

An embodiment of an article of manufacture
according to the present invention is a computer usable
20 medium having computer readable program code
instructions embodied therein to cause a computer to
determine when to send a signal. The instructions may
have computer readable program code modules to (a) cause
the computer 500 to receive a first time duration
25 corresponding to a first action signal, (b) cause the

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computer 500 to determine a first received time
corresponding to the current time indicated by a clock
when the first time duration was received, (c) cause the
computer 500 to determine a first expiration time, the
5 first expiration time being approximately equal to the
first received time plus the first time duration, (d)
cause the computer 500 to receive a second time duration
corresponding to a second action signal, (e) cause the
computer 500 to determine a second received time
10 corresponding to the current time indicated by the clock
when the second time duration was received, (f) cause
the computer 500 to determine a second expiration time,
the second expiration time being approximately equal to
the second received time plus the second time duration,
15 (g) cause the computer 500 to compare the first
expiration time to the second expiration time, (h) cause
the computer 500 to select the first expiration time if
the first expiration time is less than the second
expiration time, and to cause the computer 500 to select
20 the second expiration time if the second expiration time
is less than the first expiration time, and to cause the
computer 500 to select both the first and second
expiration times if the first expiration time is
approximately equal to the second expiration time, (i)
25 cause the computer 500, if the first expiration time is

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not approximately equal to the second expiration time,
to set a signal send time approximately equal to the
selected one of the first expiration time and the second
expiration time, and to cause the computer 500, if the
5 first expiration time is approximately equal to the
second expiration time, to set a signal send time
approximately equal to the first and second expiration
time, (j) cause the computer 500 to determine a start
time corresponding to the current time indicated by the
10 clock, (k) cause the computer 500 to determine a time
difference between the signal send time and the start
time, (l) cause the computer 500 to set a time period of
a timer approximately equal to the time difference so a
call back signal is sent at the end of the time period,
15 (m) cause the computer 500 to start the timer at the
start time, and (n) cause the computer 500 to send, once
the timer sends the call back signal, the first action
signal if the first expiration time was selected, and to
send the second action signal if the second expiration
20 time was selected.

The computer readable program code instructions in
the article of manufacture may also have modules that
(a) cause the computer 500 to select a next expiration
time once the timer sends the call back signal, wherein
25 the next expiration time may correspond to the first

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expiration time if the first expiration time was not previously selected, and the next expiration time may correspond to the second expiration time if the second expiration time was not previously selected, (b) cause
5 the computer 500 to determine a new start time, and (c) cause the computer 500 to determine a new time difference between the next expiration time and the new start time. Furthermore, the computer readable program code instructions may include a module that causes the
10 computer 500 to set the time period approximately equal to the new time difference, and that causes the computer 500 to start the timer at the new start time.

The computer readable program code instructions on the article of manufacture may also have modules that
15 (a) cause the computer 500 to check a first indicator upon sending the first action signal, the first indicator corresponding to whether the first action signal should be sent again, (b) cause the computer 500 to receive again the first time duration if the first
20 indicator indicates the first action signal should be sent again, (c) cause the computer 500 to determine a third received time corresponding to the current time indicated by the clock when the first time duration was received again, and (d) cause the computer 500 to
25 determine a third expiration time, the third expiration

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time being approximately equal to the third received time plus the first time duration.

A second example of the computer readable program code instructions on the article of manufacture may have modules that (a) cause the computer 500 to receive a set of durations, the set of durations including at least two time durations, each duration corresponding to a respective action signal to be sent at the end of the respective duration, (b) cause the computer 500 to determine a received time for each duration, each received time being a current time indicated by a clock when the duration was received, (c) cause the computer 500 to determine an expiration time corresponding to each duration to provide a set of expiration times, each expiration time being approximately equal to the corresponding received time plus the corresponding time duration, (d) cause the computer 500 to compare the expiration times to determine which of the expiration times is first to occur, (e) cause the computer 500 to select the expiration time that is first to occur to provide a selected expiration time, (f) cause the computer 500 to determine a start time corresponding to the current time indicated by the clock, (g) cause the computer 500 to determine a time difference between the selected expiration time and the start time, (h) cause

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the computer 500 to set a time period of a timer approximately equal to the time difference, the timer being capable of sending a call back signal at the end of the time period, (i) cause the computer 500 to start the timer at the start time, and (j) cause the computer 500 to send, once the timer sends the call back signal, the action signal that corresponds to an expiration time corresponding to the selected expiration time.

The computer readable program code instructions may include modules that (a) cause the computer 500 to select from the set of expiration times the expiration time that is next to occur, (b) cause the computer 500 to determine a new start time corresponding to the current time indicated by a clock, (c) cause the computer 500 to determine a new time difference between the selected expiration time that is next to occur and the start time, (d) cause the computer 500 to set the time period approximately equal to the new time difference, (e) cause the computer 500 to start the timer at the new start time, (f) cause the computer 500 to send, once the timer sends the call back signal, the action signal that corresponds to an expiration time corresponding to the selected expiration time that is next to occur.

5 The computer readable program code instructions may include a module that causes the computer 500 to add to the set of expiration times an expiration time that is approximately equal to the time the action signal was sent plus the corresponding duration. Furthermore, the second example of the computer readable program code instructions may include a module that causes the computer 500 to check an indicator corresponding to the sent action signal to determine whether the indicator is
10 turned on or turned off, and may also have a module that causes the computer 500 to add to the set of expiration times an expiration time approximately equal to the time the action signal was sent plus the corresponding duration, if the indicator is turned on.

15 In a third example of the computer readable program code instructions there may be modules that (a) cause the computer 500 to receive first timing information corresponding to a first action signal, the first timing information including a first duration and a first flag, (b) cause the computer 500 to determine a first
20 expiration time, if the first flag indicates an active status, and to include the first expiration time in a set of expiration times to be considered, (c) cause the computer 500 to receive second timing information
25 corresponding to a second action signal, the second

timing information including a second duration and a
second flag, (d) cause the computer 500 to determine a
second expiration time, if the second flag indicates an
active status, and to include the second expiration time
5 in the set of expiration times, (e) cause the computer
500 to determine which of the expiration times in the
set will occur first, to provide a selected expiration
time, (f) cause the computer 500 to determine a start
time, (g) cause the computer 500 to set a time period of
10 a timer approximately equal to a difference between the
selected expiration time and the start time, the timer
being capable of sending a call back signal at the end
of the time period, (h) cause the computer 500 to start
the timer at the start time, (i) cause the computer 500
15 to send, once the timer sends the call back signal,
action signals that correspond to an expiration time
corresponding to the selected expiration time.

The computer readable program code instructions may
include a module that causes the computer 500 to set at
20 least one of the flags corresponding to the selected
expiration time to an inactive status once the
corresponding action signal is sent. Furthermore, the
third example of the computer readable program code
instructions may also have a module that handles timing
25 information that includes a first indicator. Such a

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module may cause the computer to (a) determine whether
the indicator is turned on or turned off upon sending
the first action signal, (b) determine whether the first
flag indicates an active status, (c) determine a third
5 expiration time corresponding to the first action
signal, if the first flag indicates an active status and
the indicator is turned on, and to include the third
expiration time in the set of expiration times to be
considered, (d) determine which of the expiration times
10 in the set will next occur to provide a new expiration
time, (e) determine a new start time, (f) set the time
period approximately equal to a difference between the
new expiration time and the new start time, (g) start
the timer at the new start time, and (h) to send, once
15 the timer sends the call back signal, action signals
that correspond to an expiration time corresponding to
the new expiration time.

When the first timing information further includes
an indicator, the computer readable program code
20 instructions may include modules that cause the computer
500 to (a) determine, upon sending the first action
signal, whether the first indicator is turned on or
turned off, and (b) set the first flag to an inactive
status if the first indicator is turned off.

Although the invention has been described with respect to one or more particular embodiments, it will be understood that other embodiments of the invention may be made without departing from the spirit and scope of the invention.